PAYLOAD OPERATIONS MANAGEMENT OF A PLANNED EUROPEAN SL-MISSION EMPLOYING ESTABLISHMENTS OF ESA AND NATIONAL AGENCIES

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ABSTRACT

Spacelab (SL)-missions with Payload Operations (P/L OPS) from Europe involve numerous space agencies, various ground infrastructure systems and national user organisations. An effective management structure must bring together different entities, facilities and people, but at the same time keep interfaces, costs and schedule under strict control.

This paper outlines the management concept for P/L OPS of a planned European SL-mission. The proposal draws on the relevant experience in Europe, which was acquired via the ESA/NASA mission SL-1, by the execution of two German SL-missions, and by the involvement in, or the support of, several NASA-missions.

INTRODUCTION

In the decade subsequent to SL-1, SL-utilization in Europe was performed mainly within the framework of the German SL-missions D1 and D-2. Building upon the contributions of DLR and German industry to SL-1, the D-missions were conceived such that the Mission Management was entrusted to DLR-management directorate in Cologne. The main project tasks to be managed were:

- integration & test of P/L & P/L-systems;
- P/L OPS (including P/L-crew training);
- control of development or interfaces to experiments, facilities or racks;
- NASA-interfaces (JSC as lead center).

Systems engineering and development of P/L-system H/W&S/W was performed by ERNO/Bremen (now DASA), as well as integration and test of the whole P/L complement prior to its delivery to KSC.

Experiment H/W&S/W (and respective user support) were built or provided mostly by German entities, but also by other parties.

P/L OPS was taken care of by DLR-technical directorate (with a SL-P/L simulator in Cologne, and the P/L OPS Control Center/ [POCC] in Oberpfaffenhofen).

During P/L OPS preparation, main activities took place at DLR-Cologne, subsequently moving to DLR-Oberpfaffenhofen, concentrated there during flight.

Accordingly, the POCC control team was composed of Rhinelanders and Bavarians (plus engineers from Northern Germany). For both D-missions, the lead position was manned by DLR personnel.

In addition to the D-missions, ESA and/or national agencies such as DARA were involved in other SL-missions via provision of either astronauts or experiments/ facilities, thereby gaining further relevant experience.

Especially during IML-2, experimenters in user centers across Europe could control their experiments and/or transfer commands via MSFC POCC, using a precursor of the network planned by ESA for the Space Station era.

PLANNED EUROPEAN SL-MISSION

The contribution of ESA to the Space Station, the so-called Columbus Program, contains a Precursor Flights Program Element. The foremost goal of the Precursor Flights Program is "to prepare the European space user community, ESA and the participating states for the Space Station/Columbus era". The last programmatic document (Feb. 94) of ESA still maintains an SL-mission but, due to financial limitations, as a participation in a multilateral flight only. However, the program would be better served by an SL-mission led by ESA, as foreseen in earlier declarations of the Columbus Program, under the name "E1".

TECHNICAL SET-UP / SCHEDULE

In the last years, several investigations regarding an "E1" were carried out for ESA [Klein/Sobick, 1992; Mueller, 1992]. The last studies conducted for ESTEC could draw on recent NASA-experience with SL-missions of extended duration, and show the feasibility of the following configuration, though for some of the orbiters only [Joensson et al., 1994]:

> Short tunnel, long SL-module, EDO-kit,
> plus an exposed platform in cargo bay.

This would allow not only the accommodation of experiments and users from many disciplines other than micro-g, but also the operation of the payload in a manner more oriented towards the increment-type of operations planned for the Space Station era. In addition, the involvement of user centers could be further enhanced, and the ground infrastructure foreseen for the Space Station/Columbus era tested more extensively.

Since NASA plans to phase out SL during 1998, a launch prior to that date has to be aimed for. Taken together with the timespan of roughly 3.5 years, which is deemed necessary for preparing such an SL-flight as envisaged above, a launch in 1998 would only leave an absolute minimum on time before commencement of technical implementation.

ORGANISATIONAL SET-UP

The discussion of the mission implementation organisation foreseen will deal mainly with the pre-flight phase. The in-flight activities will be touched on only briefly, since those are too dependent on the actual requirements of the P/L.

For a rough overview of the pre-flight organisation see Fig.1; the outermost columns show only those tasks of DASA and USOCs which are considered relevant for the following discussion.

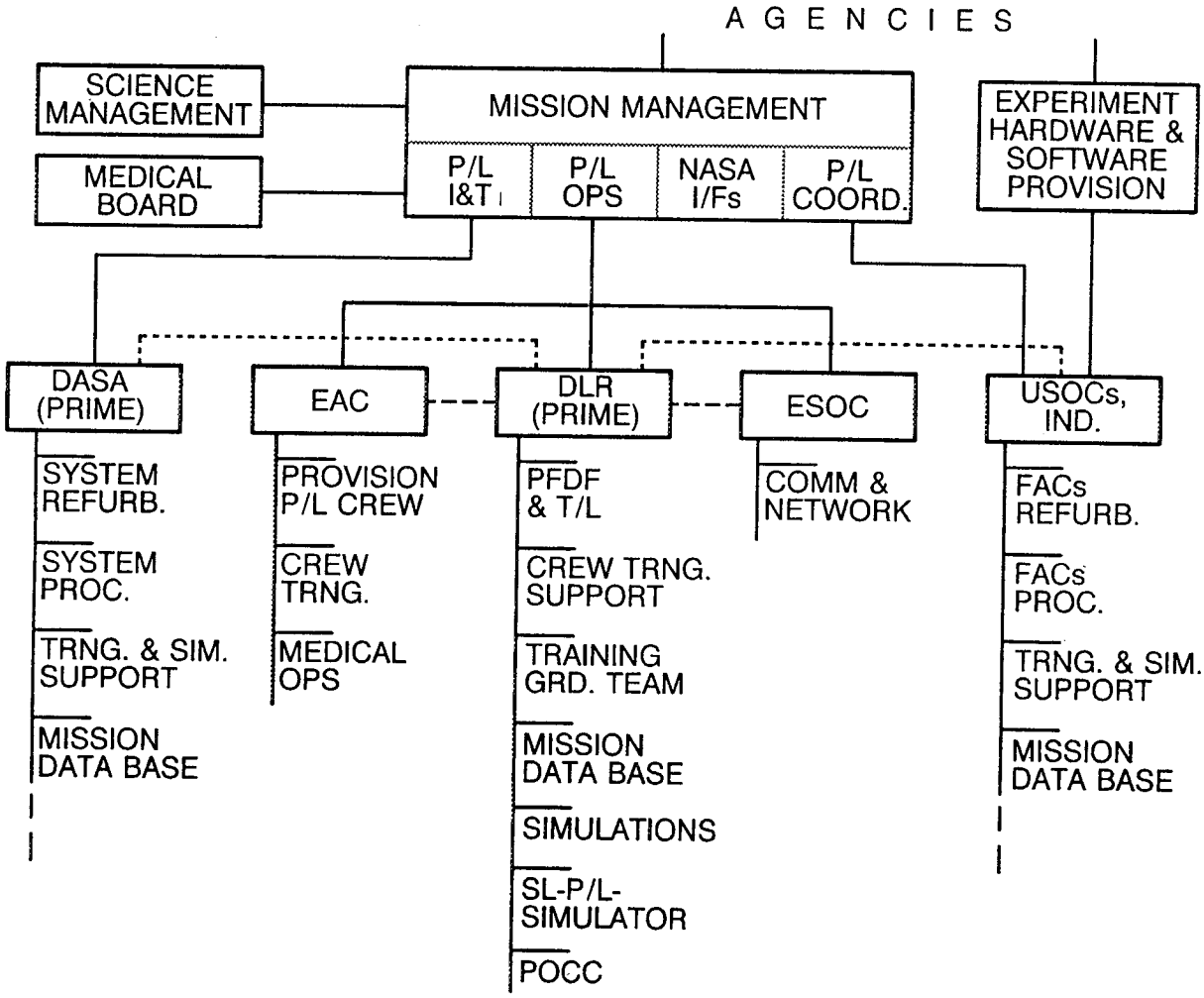

Figure 1 : Pre-flight Mission Implementation Organisation planned for E1 (adapted from Joensson et al.,1994).

One major difference as compared to D-missions is that mission management will be with ESA. The actual composition and location of that team will depend on negotiations with the agencies providing experiment H/W&S/W to E1.

Since for E1 every experiment H/W&S/W will be provided by third parties, mission management will control only the interfaces of the P/L system to the H/W & S/W in question (which may vary from simple experiments up to dedicated racks).

Integration and operations are foreseen to be contracted out again to DASA/ ERNO and DLR-technical directorate, but this time DASA and DLR will each have to lead a group of European firms, those consortia being structured and balanced according to the internal regulations of ESA.

Furthermore, the existing operations infrastructure has to be adapted to the existing ESA-organisation, which means

- that the tasks with respect to P/L-crew & P/L -Crew training plus medical operations will be under the responsibility of the European Astronaut Center (EAC) in Cologne,

- and that the European Space Operations Center (ESOC) in Darmstadt will be in charge of the network in Europe.

Moreover, whereas in D-2 two user centers were involved, for E1 at least three fully-fledged, national User Support Operations Centers (USOCs) in France, Germany and Italy will play a major role.

In addition to their standard services, it is likely the USOCs will be entrusted by their agencies with the development/refurbishment of experiment H/W&S/W for E1. This implies a transfer of tasks performed so far by industry to the USOCs.

From DLR, other tasks will be transferred to those USOCs, e.g. the development/ adaptation of crew procedures for the above-mentioned experiment H/W&S/W. Similarly, the tasks concerning the crew procedures for P/L-system H/W&S/W (experiment-support and mission-specific equipment) will be shifted from P/L OPS to DASA.

The remainder of the tasks will, again, be the responsibility of DLR-technical directorate. However, whereas already for the D-missions subcontractors to DLR were employed, more of those firms, but from other ESA states, will have to be considered.

Regarding in-flight activities, the POCC control team might include members of EAC (crew I/F, medical operations) and of ESOC (network I/F), though it is still assumed the lead position will be manned again by DLR personnel.

Since many experiment operations will be performed as "telescience", this would require the capabilities to check and plan resources, to generate commands, to change and control procedures, and to archive data at the USOCs concerned.

Consequently, most experiment operations would be transferred from the DLR POCC to the USOCs, necessitating already in that area the use of a centralized P/L data base. However, such a common mission data base would, in addition, support the integration & test activities of DASA, and the performance of simulations by DLR, as well as the overall cooperation with NASA.

CONSEQUENCES FOR MANAGEMENT OF P/L OPS

Quite a number of tasks of P/L OPS, which for D-missions were under the sole responsibility of DLR-technical directorate, would in the case of an E1-mission be transferred from DLR to EAC and ESOC, and other activities be moved from DLR to USOCs and DASA.

Thus, the number of interfaces to be managed by mission management would increase significantly, and some of those will need some special attention.

EAC will be supported by DLR-technical directorate regarding P/L crew training in the frame of a special DLR-ESA agreement, and regarding medical operations by a consortium including a DLR research institute. As concerns the P/L-crew procedures tasks to be transferred, one of the USOCs to be considered will be the Micro-Gravity User Support Center (MUSC) of DLR.

However, the planned merger of the two DLR space operations departments, the Crew Training Center (housing the SL-P/L simulator) in Cologne and the German Space Operations Center (housing the POCC) in Oberpfaffenhofen into a single organisation will remove one interface.

Nevertheless, much of the P/L OPS relevant management which in the case of the D-missions was performed by P/L OPS itself, would for an E1 have to be performed from the level above, i.e. from mission management itself (as is foreseen for the Space Station/Columbus era).

Though all the parties concerned will use far more electronic tools, data bases and networks as compared with D-missions, the configuration control of those across DASA, DLR, EAC, ESOC and USOCs will require a significant effort not only by the parties just mentioned, but also by mission management.

However, one does not expect that inter-office communication will allow a paperless management of P/L OPS for an E1. Considering the multitude of parties involved, many papers will still have to be exchanged and evaluated, but made compatible only to the extent necessary, thus avoiding unnecessary efforts just for the sake of standardization.

Moreover, in the course of mission preparation, face-to-face contact of as many of the people likely to be involved in the actual flight (from working meetings to simulations) at the earliest possible stage will greatly enhance the probability of a successful E1 implementation.

CONCLUSION

The European SL-mission, E1, as described above is planned as a precursor to the Columbus era. The decentralization of activities foreseen for E1 will be a baseline for the Space Station/Columbus era. Therefore, many more parties will have to be involved in the project task P/L OPS as compared to the former D-missions, implying that far more interfaces would have to be controlled by mission management.

Due to the nature of tasks distributed among those parties, their interfaces would be rather complex, and use of modern tools for information dissemination will necessitate a considerable effort being put into configuration control.

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